RTCA Special Committee 209

Working Group #1

Mode S Transponder Development and Maintenance

Meeting #2

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Capability to Report the TCAS Version via Transponder Message

Revision 1

Stuart Searight
Co-Chair, RTCA SC-147 for TCAS

SUMMARY

This Working Paper presents an email from Stuart Searight, Co-Chair of RTCA SC-147 for TCAS, discussing the issue of assigning one or more bits to report the version or capability of the TCAS system.

[Original email sent 24 May 2007 to: Antoine.herve@aviation-civile.gouv.fr, azeitlin@mitre.org, Carl Jezierski/ACT/FAA@FAA, david.bowen@skynet.be, drumm@ll.mit.edu, Edward CTR Glowacki/ACT/CNTR/FAA@FAA, Gary CTR Furr/ACT/CNTR/FAA@FAA, James H Williams/AWA/FAA@FAA, john.law@eurocontrol.int, Ken.Carpenter@atc.qinetiq.com, kevin.s.wilson@honeywell.com, mikael.ponnau@aviationcivile.gouv.fr, pjp@arinc.com, rhsaffel@rockwellcollins.com, rhssx@msn.com, roland.mallwitz@dfs.de, Ronald L Stroup/AWA/FAA@FAA, ruyjr.brandao@honeywell.com, Thomas Pagano/ACT/FAA@FAA, vaorlandojr@aol.com**]**

As most of you are aware, RTCA SC-147 is currently updating the TCAS II MOPS to DO-185B. With the introduction of DO-185B TCAS II systems to the NAS, the FAA's Safety and Risk Management System (SRMS) requires that the system's performance be monitored. This is also desirable by the Program Office so that the FAA can analyze TCAS II overall TCAS performance and work to identify if any other problem encounter types exist in which TCAS does not adequately provide collision avoidance guidance.

In order to analyze TCAS performance, it will be critical to know the version of TCAS systems that are recorded in the monitoring efforts. The RTCA committee working on updating the Transponder MOPS (SC-209) has already deliberated on this issue and has ideas on how to best implement a TCAS II version indicator by using bit 72 in the Data Link Capability report. During the recent SC-147/WG-75 meetings, however, it was noted that Annex 10 has already defined Bit 72 to indicate if the system is Hybrid Surveillance capable or not. Further, it appears that ARINC characteristics must be updated to ensure that TCAS systems properly convey their version to the transponder. (Details are found in the attachment to this email.) While all of these standards are currently "open" and being updated, coordination between all of these activities is needed so that this operational need can be met.

Given all stated above, I would like to pose a few targeted questions to the different groups involved. After all of us see those replies, I hope that all needed activities can move forward to provide this reporting capability of TCAS versions. If closer coordination is needed between SC-209, WG-49, ASP, and/or the ARINC group, SC-147 would gladly organize and facilitate those discussions.

Questions:

Ruy Brandao: Did the Hybrid Surveillance MOPS recognize the Annex 10 definition of Bit 72 and place a requirement that Hybrid Surveillance capability be provided to the transponder? Does any manufacturer plan to implement this reporting? (If the answers are "no", perhaps Bit 72 can be redefined and used as initially considered.)

Roland Mallwitz: Could you describe the scheme you proposed this week on the register 10 bits that are undefined?

Paul Prisaznuk, Bob Saffell, and Tom Pagano: Do you agree that changes to ARINC 735 are needed so that TCAS II version can be reported to the transponder? Paul, would these be straight forward changes that could be easily accommodated?

Vince Orlando: Do you recall the reasoning behind the Annex 10 specification to report Hybrid Surveillance capability? Is any use of this information currently envisioned?

I thank all of you for your time to consider these matters and hope that all of our committees can work together to meet the operational need to report TCAS II version for FAA (and European) monitoring purposes.

Responses:

From Ruy Brandao, 24 May 2007:
Regarding Hybrid Surveillance
- We did not address bit 72
- There is no support in the ARINC spec to communicate this bit to the transponder

From Paul Prisaznuk, ARINC Standards Development, 28 May 2007:
Proposal from SC-147/WG-75 to add TCAS Version number is appreciated. The plan at ARINC is to include this in Project Paper 735B, with new draft expected to be available in July (August at the latest) at www.arinc.com . All interested parties are invited to provide comments on the document.

Henceforth in this document, all references to RTCA/DO-185A shall include subsequent revisions (e.g., RTCA/DO-185B).

1.0 INTRODUCTION AND DESCRIPTION

1.1 Purpose of this Document

This Characteristic describes a Traffic Alert and Collision Avoidance System (TCAS) that provides the necessary interface definitions and protocols to accommodate the requirements of RTCA/DO-185A.

RTCA/DO-185A, "Minimum Operational Performance Standards for Traffic Alert and Collision Avoidance System (TCAS) Airborne Equipment", requires an increase in the amount of data to be transferred from TCAS to the transponder than was required by RTCA/DO-185. Specifically, the Resolution Advisories Report and Data Link Capability Report are expanded. In addition, the protocol is expanded to allow TCAS to request data contained in the ground initiated COMM-B buffers of the on-board MODE S transponder and provides definition of the protocol used by the transponder for delivery of such data. The TCAS/Transponder Interface and Protocol definitions provided in Attachments 6A through 6Z are not used to satisfy the requirements of RTCA/DO-185A. They are retained to enable the upgraded TCAS to operate in accordance with the requirements of RTCA/DO-185 when paired with an older transponder that cannot support the requirements of RTCA DO-185A.

COMMENTARY

The TCAS system described by this document is designed to be backward compatible with Mode S transponders defined by ARINC Characteristic 718 which are only compatible with RTCA/DO-185. The TCAS system is also compatible with Mode S transponders defined by ARINC Characteristic 718A, which are compatible with both RTCA/DO-185 and RTCA/DO-185A.

1.2 System Description

The U.S. National Aviation Standard on TCAS, FAA Document 6367.1, describes the "signal-in-space" standard. The RTCA/DO-185A, "Minimum Operational Performance Standards for TCAS", provides an essentially complete technical description of the TCAS system.

1.3 TCAS

The function of TCAS is to determine the range, altitude and bearing of other aircraft equipped with Mode S/ATCRBS transponders with respect to the location of own aircraft. The system monitors the trajectory of these aircraft for the purpose of determining if any of them constitute a potential collision hazard. The system is responsible for estimating the separation at closest approach and determining if a potential conflict exists. If so, the system should display an advisory to the pilot. In cases defined in this document, the system should also provide guidance for the optimum vertical avoidance maneuver. The correctness of the avoidance maneuver is ensured by coordination of mutual intentions with the other TCAS equipped aircraft through the Mode S transponder.

1.4 Unit Description

1.4.1 TCAS Computer Unit

The TCAS computer unit should house all of the components incident to the functioning of the TCAS system other than those necessary to effect the display of collision avoidance and traffic advisories to the aircrew, for flight crew control of system operation, and electronics necessary at the antenna.

1.4.1.1 TCAS Computer Unit Sensitivity Level

TCAS sensitivity level selection will have three modes: Automatic, Standby and Traffic Advisory (TA) only. In the Automatic mode, sensitivity level selection will be made by the computer unit in accordance with inputs from the radio altimeter and the barometric altimeter. Sensitivity level of TCAS can also be affected by ground station commands. When the automatic mode is selected, both traffic advisories (TA) and resolution advisories (RA) are generated when appropriate. In the Standby mode, TCAS RF interrogations are inhibited and TCAS cannot generate TAs or RAs.

1.4.2 Control Unit

Any needed manual control for the TCAS unit should be provided on the control panel of its associated Mode S Transponder unit. As there is no direct link between this control panel and the TCAS unit, control information will be delivered to the TCAS via the transponder. The control panel should provide the needed interface to the Mode S transponder required for the TCAS system. Communications links from the Mode S transponder unit to the TCAS should be the two-wire serial digital system described in ARINC Specification 429, "Mark 33 Digital Information Transfer System (DITS)." Details of the Mode S Transponder control panel are contained in ARINC Characteristic 718A, "Mark 4 Air Traffic Control Transponder (ATCRBS/MODE S)."

1.4.3 TCAS Display

Collision avoidance maneuver advisories and traffic advisories may be displayed to the cockpit crew on one or more dedicated displays, on displays integrated with other instruments such as Instantaneous Vertical Speed Indicator (IVSI), or on a CRT flight instrument.

1.4.4 Antennas

The installation should provide two L-band transmit/receive antennas for each TCAS on the aircraft, one located on the underside of the fuselage and the other on top. The upper antenna will provide the TCAS computer unit with signals for an estimation of the signal angle-of-arrival. The lower antenna may be an omni-directional blade antenna or directional antenna at the option of the user.

COMMENTARY

This document assumes that the minimum configuration will use the omni-directional blade for the lower antenna.

ATTACHMENT 19G
TCAS TO TRANSPONDER (TX) DATA LINK CAPABILITY REPORT
RTCA/DO-185A COMPATIBLE EQUIPMENT

Table 19G-1c LABEL 270: SEGMENT 2
TCAS TO TRANSPONDER (TX)
TX Coordination #1 Out Bus
TX Coordination #2 Out Bus

Bit	Function	Coding	RF Msg Bit	Notes
1	Label 1st Digit (MSB)	2 1		
2	Label 1st Digit (LSB)	0		
3	Label 2nd Digit (MSB)	7 1		
4	Label 2nd Digit	1		
5	Label 2nd Digit (LSB)	1		
6	Label 3rd Digit (MSB)	0 0		
7	Label 3rd Digit	0		
8	Label 3rd Digit (LSB)	0		
9	Not Used by TCAS	0	57	[3]
10	Not Used by TCAS	0	58	[3]
11	Not Used by TCAS	0	59	[3]
12	Not Used by TCAS	0	60	[3]
13	Not Used by TCAS	0	61	[3]
14	Not Used by TCAS	0	62	[3]
15	Not Used by TCAS	0	63	[3]
16	Not Used by TCAS	0	64	[3]
17	Not Used by TCAS	0	65	[3]
18	Not Used by TCAS	0	66	[3]
19	Not Used by TCAS	0	67	[3]
20	Not Used by TCAS	0	68	[3]
21	BIT 69	As Required	69	[6], [8]
22	BIT 70	As Required	70	[6], [8]
23	BIT 71	As Required	71	[7], [8]
24	BIT 72	As Required	72	[7], [8], ~~[9]~~
25	Segment Number Bit_0 (LSB)	0		
26	Segment Number Bit_1	1		
27	Segment Number Bit_2	0		
28	Segment Number Bit_3 (MSB)	2 0		
29	Continuation Bit	0		[10]
30	Request/Delivery Bit	0		[2]
31	Pad	0		[2]
32	Parity	(Odd)		

ATTACHMENT 19G
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NOTES:

[1]. For the Data Link Capability Report, Segment 0, the GICB Register or Buffer Number is equivalent to the BDS Buffer Number. This may or may not be the case for other messages to be transferred via the TGD protocol.

[2]. The "SSM" field is not required for the TGD protocol since it is assumed that the data being sent to the Transponder is valid; otherwise, the TCAS should not be sending it. Status of the TCAS/Transponder system is provided to the Transponder by the TCAS via TXWORD2 (Label 274) and TXWORD3 (Label 275).

[3]. .These bits are not used by TCAS: therefore, TCAS should ensure that theses bits are set to ZERO. These bits will be set by other equipment (i.e., transponder) in accordance with RTCA DO-218.

[4]. Bit 48, Coding:

Bit 48 should be set to ONE by a TCAS operating at a sensitivity level in the range of 2 through 7. Bit 48 should be set to ZERO by a TCAS operating at a sensitivity level of 1, or if TCAS has detected a failure, or if the TCAS is being powered down.

[5]. This RF Message bit will be set to ZERO by the transponder if it detects a failure of the TCAS/Transponder interface.

[6]. Bit 69,70, Coding:

The TCAS should provide the appropriate coding of these bits to the transponder via the TCAS interface. Such coding should be in accordance with the TCAS capability as follows:

When Bit 48 = 1, coding:

0 = TCAS II is operating, generating Traffic Advisories (TAs) only
1 = TCAS II is operating, generating TAs and RAs
2 = TCAS IV is operating, generating TAs only
3 = TCAS IV is operating, generating TAs and RAs

When Bit 48 = 0, coding:

0 = TCAS is not installed, TCAS is not operational, or TCAS has failed
1 = TCAS II is in the Standby Mode
2 = Not Assigned
3 = TCAS IV is in the Standby Mode

[7]. Bit 71 coding:

~~Bit 71 should be set to ONE if and only if the "274" TXWORD2 "V1" = ONE and if the "276" XTWORD6 "V1" = ONE, indicating that the TCAS/Transponder System is Change 7.0 compatible.~~

[8]. These RF Message bits will be set to ZERO by the transponder if it detects a failure of the TCAS/Transponder interface.

[9]. This bit is Reserved for future use by TCAS and/or the Transponder. Until appropriate coding of this bit has been defined, it should be set to "0".

[10]. The Continuation Bit in Segment 2 may be set to ZERO since there are no further Data Link Capability Report data bits that are set by TCAS that would need to be transferred to the transponder in subsequent segments. If the Continuation Bit in Segment 2 is set to 1, then the Data Link Capability Report transfer should proceed in accordance with the TGD protocol.

BITS 72	BITS 71	Meaning
0	0	6.04a TCAS II
0	1	DO-185A TCAS II
1	0	DO-185B TCAS II
1	1	Reserved

These bits indicate the version of the TCAS II Computer Unit.